WHAT MATHEMATICS GRADUATE TEACHING ASSISTANTS VALUE IN A PROFESSIONAL DEVELOPMENT PROGRAM

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Abstract

Many mathematics graduate students will be a teaching assistant at some point in their time at graduate school; however, few of them have any prior teaching experience. Fortunately, many universities offer a professional development (PD) program to help prepare Graduate Teaching Assistants (GTAs) for teaching. Little research has been done on GTA's perceptions of their PD experience. This study aimed to address this issue by answering the question, "what do GTA's value in the PD experience?" To answer this question, a survey was sent to all mathematics, applied mathematics, and statistics graduate students at a southwestern university. After the survey, 12 GTAs agreed to be interviewed. Through the survey and interviews, five themes arose in what GTAs value: interactions with peers, interactions with teaching supervisors, collaborative learning spaces, observations of instructors as an undergraduate and graduate student, and support provided through PD. From this study, recommendations are given for PD programs to consider.

Chapter 1: Introduction

Starting graduate school caused mixed emotions for me. I was excited to further my education in mathematics, meet peers/educators/colleagues from all different backgrounds, and decide what career path I wanted to pursue with my degree. Yet I was intimidated, for I knew my classes would be very challenging, I had to find a new cohort for studying, as well as meet new professors. There was one other aspect of graduate school that was very intimidating to me: being a graduate teaching assistant (GTA).

When I first heard that I would be a GTA, I was not sure what it would entail. What would be my responsibilities? I first thought that a GTA would do a lot of grading for a professor of a class. Otherwise I would lead recitation sessions. Maybe I would be holding extra office hours for some professor. Or, the most daunting version of all. Teaching my own class.

I was glad to find out that the mathematics department offered an orientation program for new GTAs prior to their first semester as a GTA. One of the first things I discovered during this orientation was that my scariest version of a GTA's duties was true: I would be teaching my very own section of college algebra. Immediately about 100 questions came to my mind. *How do I know what to teach to my students? Do I have to create a syllabus? What even goes into a syllabus? Do I have to create tests? How do I know what questions to ask? How will I be able to respond to student questions immediately? How can I get over my nerves of public speaking? How do I get students that are, at most, five years younger than me to respect me?* The list was endless.

The orientation helped answer some of my questions, such as class management, time management, as well as information about the specific course we were all teaching. We even had a chance to practice teaching a specific mathematics problem to a group of GTAs and provided

each other constructive feedback. The orientation also introduced me to concepts that I was unfamiliar with, like dealing with student conflict, how to use the course website, as well as laws like the Family Educational Rights and Privacy Act, or FERPA, which protects the privacy of educational records.

While the orientation helped me with certain aspects of my teaching duties, there were other aspects for which my prior tutoring experience was very helpful. Tutoring taught me how to care for my students and to pay attention to their understanding. Through tutoring, I also learned how to explain the content in a way that a college student would understand, as well as realize the importance of teaching multiple approaches to solve a problem.

When talking to my fellow GTAs, I realized that some of them did not have the previous experiences that I did teaching. Some had difficulty relating to students. Others struggled with teaching content in a way that their students would understand. And even some had difficulty caring about how their students did in their class, for they were busy with their own studies. What seemed even worse to me was that some did not realize the impact their teaching would have on not only their students' success in their class, but potentially their students' overall college success.

My own experiences as a GTA, as well as conversations with my fellow graduate students, led me to an interest in how GTAs are prepared to teach. During their undergraduate career, many students take an entry level mathematics course to either pursue a STEM related field, fulfill a requirement, or even pass an elective. Often many of these mathematics courses are taught by mathematics GTAs. While these graduate students have the mathematics knowledge, few have experience teaching. Some have previous tutoring experiences like me, yet, others have no experiences related to teaching. This situation is worrisome because we are

expected to teach, but we have little to no experience teaching. Teachers at the K-12 level have to take specific courses pertaining to their content area alongside courses that discuss content specific to teaching methods, student behaviors, development, how to approach learning disabilities and exceptionalities, etc. This suggests that there are certain aspects of teaching unrelated to content knowledge that are vital prerequisites to teaching.

I also learned that many GTAs use traditional methods of teaching such as lecturing. Prior to doing some research, I only used lecturing as well, for this was the only method I had seen in my graduate/undergraduate mathematics courses. Thus, when I began as a GTA, I was not aware of other teaching methods. Yet, after some reading, I found current research supports active learning methods as being potentially more successful for undergraduate mathematics courses.

Based on my reading of relevant research, my own experiences, and talking to fellow GTAs, I became interested in mathematics graduate students' experiences in professional development programs. I decided to conduct a research study to gain an understanding of GTAs' perception of the effectiveness of the different professional development (PD) components they participated in throughout their years as GTAs. Specifically, my research question is what do GTAs value in the PD experience? For my study, I surveyed 35 GTAs and conducted interviews with 12 of the survey respondents. Through this research, I hoped to find ways to improve the professional development program offered so GTAs feel better prepared for their teaching obligations. Strengthening the preparation of teaching assistants is important, as this may positively impact the success rate and experiences of students at all levels. Not only does GTA PD prepare graduate students for teaching, it prepares the future collegiate educators, for some graduate students will continue a career in teaching where there may be few opportunities for

further PD. Many times, the only teaching preparation offered to these future educators is the preparation received as a GTA. Thus, strong GTA preparation can help shape the future success of college students in mathematics courses. In what follows, I first provide an overview of the literature on the topic of PD for GTAs. I then turn to my study by first describing the methods, followed by the results and discussion of the findings. I end with implications for future research and recommendations for PD programs.

Chapter 2: Literature Review

GTAs play an important role in college mathematics. In many universities, they are the primary teachers for lower level mathematics. Thus they have the sole responsibility of teaching the mathematics skills needed for their students to either continue in mathematics, fulfill a major requirement, or even get past an elective. Yet, many GTAs have no prior teaching experiences. Quite often, GTAs receive some form of professional development (PD) to help them prepare for their teaching duties. These PD experiences may be the first in which graduate students receive any knowledge on teaching. In this section, I first provide a brief overview of the nature and history of PD for GTAs. I then discuss some key factors that have been found to influence GTAs in relation to teaching. In the third section I look at different teaching approaches, active learning in particular**.** I then discuss components of PD programs found in the literature. The final section provides current research on the evaluation of PD.

Brief overview of the nature and history of Professional Development for GTAs

Research on college education has only been around since the 1980s (Speer, Gutmann, & Murphy, 2005). Because of the well-established research base in K-12 teacher education, some researchers claim GTA development research can start by looking at how K-12 teacher education research can apply. For example, both K-12 research as well as research on college PD indicates that PD at either level (K-12 / college) should include looking at how students think (Speer & Hald, 2008; Firouzian & Speer, 2015). While looking at K-12 teacher education can be helpful, there are some differences between GTAs and K-12 teachers. Most notably, K-12 teachers are usually required to earn a degree related to teaching, yet GTAs are often not even required to take one course related to teaching (Miller et al., 2018).

Despite the limited research, the concept of PD for GTAs is not a new one. Shana'a (1965) describes a GTA PD program available for students at the University of Oklahoma in the 60s. This program involved a four-day orientation prior to teaching, weekly discussions, and peer observations. Friederich and Powell (1979) also describe a standard three-day orientation program offered for new GTAs. While these programs occurred over forty years ago, certain aspects, such as the pre-teaching orientation, appear in PD programs offered in the United States today.

Currently there are many different GTA PD programs offered at universities. Bragdon, Ellis, and Ghertz (2017) and Deshler, Hauk, and Speer (2015) report on three main types of program: 1) the basic PD program, consisting of a couple hours to a couple of days of orientation the week or so before teaching. This program sometimes includes weekly seminars during the first semester; 2) the next type of PD program includes a pre-semester orientation, as well as a semester or more of guided activities to help prepare GTAs to teach. During these meetings, discussions occur between GTAs as well as the course coordinators. Some small assignments are given, such as reading education articles; 3) the final kind of program contains all of the orientations and seminars from the previously mentioned programs, but it continues professional development after the first year. This ongoing professional development may be through seminars or course meetings. It also may include GTAs having contact with faculty members willing to help GTAs continue to improve their teaching.

Influences on GTAs

GTAs take on multiple roles during their time in graduate school. In particular, they have the student role and the teacher role. While they had the role of a student prior to graduate school, many GTAs have never experienced the teacher role. One does not just obtain a teacher

identity from becoming a teacher. It develops overtime through experiences and influences. According to DeFranco and McGivney-Burelle (2001) there are three main factors that influence mathematics teachers: social context of the teaching situation, system of beliefs, and reflection on teaching. These three factors, which are discussed in more detail below**,** help shape the teacher identity.

The social context of the teaching situation can be challenging for a GTA. As graduate students in a mathematics department, the stress is often on their role as a mathematics student. For example, in research done by Harris, Froman, and Surles (2009), they found that in four university PD programs, there was an emphasis on not letting GTA teaching duties detrimentally decrease time spent on their own studies. Austin (2002) not only found a similar situation, but GTAs noticed that faculty did not receive any repercussions for poor teaching. While the identity as a student of mathematics dominates the teacher identity for GTAs, it does not eliminate it. Through interviews with six GTAs, Beisiegel and Simmt (2012) realized that even though their identity as student was dominant, GTAs found ways to hold on to the teacher identity through grading more problems than required or pushing for the creation of a hybrid course.

Besides having an imbalance in roles, GTAs do not always feel like true members of communities to which they belong. Shultz and Herbst (2017) found that, while GTAs position themselves as members of the mathematics community, they do not position themselves as members of the institution or department for which they work. Shultz and Herbst hypothesize professors may identify more with the department because of their stability in the department, whereas GTAs' positions are temporary. Another reason GTAs may not identify with the department is because they lack power in certain aspects of teaching. GTAs can feel like they have no authority in the courses they teach due to the often rigid structure of the curriculum

(Beisiegel & Simmt, 2012; Muzaka, 2009). These curriculum structures not only distance the GTAs from feeling like they belong to the department community, but they can affect their teacher identity. GTAs' attitudes about teaching can change from wanting to be different from how their own professors teach, to feeling like what they do will not matter (Beisiegel & Simmt, 2012).

PD can help GTAs find a balance between their role as a student of mathematics and their role as a teacher. It can provide GTAs with the needed support for their teaching duties. PD can also address the lack of authority GTAs may feel. While curriculum may be set for certain courses, PD can show GTAs where they can insert some of their own ideas into the teaching. For example, PD can provide GTAs information about different teaching methods such as active learning.

The second factor that influences GTAs is a system of beliefs, which includes teaching beliefs and learning beliefs. The first few years of teaching are important in determining teaching beliefs and practices for an educator (Speer et al., 2005). For many graduate students, their role as a GTA is their first experience as a teacher. One influence on GTAs' teaching beliefs may be their own experiences as graduate students in mostly lecture based courses (Deshler et al., 2015), which does not illustrate the multiple teaching methods that educators can use to reach out to a diverse body of students.

Referring back to the research with K-12 teachers, there are four stages that teachers can go through (Beisiegel, 2017). The first stage is to survive the first year of teaching. This includes working on classroom management as well as understanding the protocols of the school. The second is consolidation, which means that teachers know what skills they have mastered and what skills they need to work on. The third is called renewal. Teachers reach a point at which

they become bored with what they are doing and want to find different ways to teach. The final stage is maturity, during which the teacher starts to look more broadly at student learning.

In his dissertation on GTAs, Belnap (2005) discovered three stages of development that GTAs go through that are similar to Beisiegel's first two stages. These three stages are investigation, implementation, and assimilation. Investigation refers to using the resources available and deciding what to use in the classroom. This stage is similar to the survival stage, for both stages use the knowledge and skills available to the instructor. The second stage, implementation, is the process of making decisions and changes to the plans. The final stage is assimilation, which involves reflecting and interpreting the experiences in the classroom. The implementation and assimilation stages relate to Beisiegel's consolidation stages, for during this time GTAs make changes to their teaching and discover what experiences, or teaching styles, can be used again. While Belnap's research argues that GTAs go through a cyclical process similar to the first two of Beisiegel's stages, Beisiegel found that some GTAs go through all four stages in their time as a graduate student.

Going through these different stages is likely to influence their teaching beliefs. DeFranco and McGivney-Burelle (2001) support this idea. Their findings show that after participating in a mandatory mathematics pedagogy course (consisting of five two-and-one-half hour meetings throughout a semester), GTAs' beliefs on teaching changed. Through activities and discussion in the classroom as well as reflection on their own teaching and teaching beliefs, GTAs went from thinking that teaching was having knowledge and giving knowledge to students since student learning was viewed as basically memorization, to thinking that learning is developing students' understanding of the material rather than just memorizing content.

PD can support GTAs while they progress through the four stages; however, many PD programs are limited to a GTA's first year of graduate school (Beisiegel, 2017). While transitioning through stages, GTAs may discover different methods of teaching and may develop different teaching beliefs. With the changes being new and potentially conflicting with prior beliefs on teaching, GTAs' teaching may not always reflect these changes (DeFranco & McGivney-Burelle, 2001). A longer, multi-year PD program may provide a more sustained opportunity for GTAs to consider different approaches to teaching.

The final influence on a mathematics instructor is reflection. Reflection is not always a common practice, especially for GTAs who have not yet taught. PD can provide regularly guided reflection for GTAs (Austin, 2002) as well as help them practice reflecting on teaching (Harris, Froman, & Surles, 2009). Through reflecting on their teaching experiences, GTAs can develop insights that can help them in their teaching (Speer & Hald, 2008). For example, they can start to understand how students think (Reinholz, Cox, & Croke, 2015) and different ways to teach content (Speer & Hald, 2008). They can also see how they have grown as an instructor through assignments offered in PD such as writing reflection papers (Wakefield, Miller, & Lai, 2017).

To summarize, the research literature points to three influences on a mathematics instructor: social contexts, beliefs, and reflection. Within the social contexts, GTAs struggle finding the balance between being a teacher and a student of mathematics. GTAs' beliefs on teaching prior to becoming a GTA generally rely on what they have seen as a student or have read in textbooks. And finally GTAs may not have experience reflecting on teaching. For these three influences, PD can provide proper support to help GTAs grow as an instructor.

Active Learning and other types of delivery of instruction

To help improve student success, universities are starting to implement active learning methods in entry level STEM courses. For example, to decrease failure rates in lower level mathematics classes, San Diego State University incorporated an active learning component to their courses (Shakerdge, 2016). According to the Conference Board of the Mathematical Sciences (2016), active learning "refer[s] to classroom practices that engage students in activities, such as reading, writing, discussion, or problem solving, that promote higher-order thinking" (p. 1).

Studies show active learning has a positive effect on student learning. For example, Bressoud and Rasmussen (2015) found successful calculus programs include active learning aspects. These programs used active learning to help students address any misconceptions as well as engage students in the classroom. Further support for the potential benefits of active learning comes from the research by Freeman and colleagues (2014), which found students scored better and the failure rate was smaller in active learning classrooms than lecture based classes. Like Freeman and colleagues, Piercy and Militzer (2017) indicate smaller failure rates in business related mathematics classes that implement active learning. They found inquiry based learning (IBL), an active learning method, helped students retain information better. Retention of content can support better scores on final exams, resulting in fewer students failing as well as supporting students in their future mathematics courses.

Many of the classroom methods determined by research as effective can be classified as active learning methods (CBMS, 2016). One common active learning method in mathematics undergraduate courses is group work (Apakarian & Kirin, 2016). Other methods include inquiry based learning (IBL) (Laursen, Hassi, Kogan, & Weston, 2014; Piercey & Militzer, 2017),

inquiry oriented instruction (IOI) (Kuster, Johnson, Keene, & Andrews-Larson, 2017), and project based learning (PBL) (Evans, Friedman, McGrath, Myers, & Ruiz, 2017). IBL focuses on students learning to construct, analyze, and support mathematical arguments through the exploration of "ill-structured but meaningful questions" (Laursen et al., 2014, p. 407). In a blog post by Elise Lockwood writes, referring to the work of Johnson, Keene, and Andrews-Larson, in IOI, "instructors use mathematically rich task sequences, small group work, and whole class discussions in order to elicit student thinking, build on student thinking, develop a shared understanding, and introduce formal language and notation" (Johnson, Keene, & Andrews-Larson, 2015, para. 5). PBL is another method "where students gain knowledge and skills by working for an extended period of time on an authentic, engaging and complex question, problem or challenge" (Evans, Friedman, McGrath, Myers, & Ruiz, 2017, p. 6). While lecturing generally focuses on presenting formal mathematics as a finished product, in active learning approaches, the instructor guides students' derivation of formal mathematics through carefully prepared problems and activities.

Active learning promotes students' participation in the mathematics class, for example through discussion (Dudley-Marling, 2013; Mesa & Chang, 2010).With more students participating in classes, teachers can get a better understanding of what students understand and what concepts need to be reviewed. Lecturing may not provide teachers with this form of assessment. Along with getting students to participate in the class, the students are taking ownership of the learning and the mathematics (Kuster et al., 2017). This sense of ownership can give students a connection to the topics covered in class.

Active learning has also been found to eliminate the gender gap in grades in mathematics (Laursen, Hassi, Kogan, & Weston, 2014). In IBL courses, women's scores were similar to

men's scores. The IBL courses also helped female students feel more confident in their mathematics abilities. In non-active learning classes, women reported gaining a less than mastery status in mathematics concepts compared to men. Yet in active learning courses, the gap between male and female students reporting mastery status vanished. For example, when students self-reported their cognitive gains using a 5 point Likert scale, the non IBL courses had a mean score of 3.81 for men and 3.54 for women; however, in the IBL courses, the women had a slightly higher mean score for cognitive gains with a mean score of 4.08 for women and 4.01 for men.

In summary, active learning seems to lower the failure rates in collegiate mathematics courses. It can promote a desire to learn mathematics by giving students a sense of ownership in the learning process. Active learning encourages student participation in the class and helps to eliminate the gender gaps in college mathematics courses.

Components of Professional Development Programs

Throughout the literature, multiple suggestions were made about what topics and activities should be included in a PD program. Common themes suggested in the literature are resources, how to interact with students, pedagogical content knowledge, different learning methods, and conducting teaching observations.

Professional Development should provide GTAs with resources (Deshler et al., 2015; Friedrich & Powell, 1979). Resources can include, but are not limited to, course schedules, course policy, course coordinators (Goldnabi, Murray, & Rahman, 2017; Shana'a, 1965), current education research and literature (Friedrich & Powell, 1979; Wakefield et al., 2017), and case studies (Harris, Froman, & Surles, 2009). As Deshler and colleagues (2015) describe, a good PD program will prepare GTAs to teach after graduate school, since some may continue with academia as a career.

GTAs need knowledge on student interactions. GTAs are closer in age to students, who may then see GTAs as more approachable than instructors (Muzaka, 2009). It is important that GTAs have knowledge about how to interact with students (Bjorkman, 2016). Interactions can include speaking in front of a class, in a small group setting, or one-on-one. PD can have GTAs present mock lessons (Cervello Rogers & Yee, 2017) or address any anxieties GTAs may have about teaching (Friedrich & Powell, 1979). PD can also discuss pedagogical empathy, the ability to express concern and to take the perspective of a student and "the influence that this ability has on teaching decisions" (Uhing, 2018, p. 994), which addresses the emotions GTAs' students may have and how to address them.

Many of the PD programs at the college level focus on the logistics of teaching such as their role as a GTA, the content they will teach, how to grade, department policies, and so on. Although these are important, there is other knowledge the GTAs need. For example, many GTAs have not taught before and may lack knowledge of teaching (Ellis, 2014; DeFranco & McGivney-Burelle, 2001). One aspect that makes an effective teacher is pedagogical content knowledge (Deshler et al., 2015; Speer & Hald, 2008; Firouzian, 2015; DeFranco & McGivney-Burelle, 2001). Pedagogical content knowledge includes understanding the way students think about a subject. This knowledge is not something that a GTA will necessarily learn from understanding the content and from their own experiences as an instructor. In fact, teachers at the K-12 level have courses addressing pedagogical content knowledge when they are earning their degree. Similarly, GTAs need to be taught what pedagogical content knowledge is and how to use it (Speer & Hald, 2008).

One important aspect that professional development can address is that there are multiple methods of teaching. Rasmussen et al. (2016) found that 60% of PD programs want more

information on the best practices. As discussed earlier, current trends in education support active learning to be an effective practice. In fact, the Conference Board of the Mathematical Sciences (2016) report some of the most effective teaching methods include active learning. Friedrich and Powell (1979) claim a professional development program should show multiple teaching methods, so GTAs can decide which one is best suited for them.

GTAs also need some form of assessment of their teaching. One common method of providing feedback for GTAs is through teaching observations. There are two main types of observations mentioned in the literature: faculty observations and peer observations.

In faculty observations the person conducting the observation may be a course coordinator or an assigned teaching supervisor. Besides observing, the faculty member can be another resource for the GTA to receive mentoring (Belnap, 2005; Deshler et al., 2015), feedback (Patitsas & Belleville, 2012), guidance on how to deliver instruction, and even calm any fears GTAs may have about teaching (Shana'a, 1965). According to a survey by Ellis (2014), around 70% of the universities in her study incorporated faculty observations along with other aspects of PD. Yet, as Austin (2002) reports, GTAs want even more mentoring and feedback from faculty and Waller (2015) also reports on GTAs needing more supervision during their time as a GTA.

Another form of observations is peer observations. According to the literature, this method is beneficial to GTAs for multiple reasons. One reason is that it provides GTAs the opportunity to observe things in the classroom that they may not notice while they are teaching (Reinholz, 2017). Another reason is that peer observations provide feedback on their teaching (Harris et al., 2009; Shana'a, 1965). Peer observations provide GTAs the opportunity to practice

reflecting (Harris et al., 2009), which can have an effect on their teaching style (Reinholz et al., 2015) and help them through the stages of development of teaching previously discussed.

One specific type of peer observations is having a peer mentor or a lead teaching assistant (TA) conduct the observations. A lead TA is an experienced GTA. This experienced GTA may have to apply or go through a process to become a lead TA (Cervello Rogers & Yee, 2017; Milbourne, 2018; Ellis, 2015). The responsibilities of a lead TA can include leading weekly discussions for GTAs, observations, and debriefing with GTAs after observations. They can become a liaison between the GTAs, course coordinators, and PD leaders (Milbourne, 2018).

One aspect of having peer observations is that it can create a sense of community between graduate students. Through peer observations, GTAs can see common struggles among their peers, learn new ideas to implement in their own teaching, as well as learn how to provide and receive constructive criticism (Reinholz, 2017). As Austin (2002) reported, GTAs recommended having opportunities to meet and talk with their peers. They can also discuss any issues they may have in balancing the student of mathematics role alongside the teacher role (Beisiegel & Simmt, 2012).

In summary, a PD program for GTAs should cover many areas related to teaching. It should prepare GTAs to interact with their students. Students will not have the level of understanding of mathematics that GTAs do, so the program should remind them of how students think and common misunderstandings they may have. The PD program should show GTAs that the methods of teaching they have seen as a student themselves are not the only methods of teaching. It should provide them with different styles so GTAs can explore these different teaching methods. The program should also provide an assessment of a GTA's

teaching. Observations are a common method used for feedback and reflection for GTAs as well as for creating a sense of community between the graduate students enrolled in the program.

Evaluation of Professional Development

Just as teachers evaluate their teaching, so too should a department evaluate the PD program offered to GTAs. A survey was sent out to all 330 graduate degree granting mathematics schools in the United States pertaining to GTA PD, and the results of the survey showed 40% of the institutions that responded were not satisfied with their current PD program (Speer, Deshler, & Ellis, 2017). One cause for this dissatisfaction is the lack of knowledge on how to evaluate a PD program. As Speer and colleagues discovered in their survey sent to department heads about the PD programs offered, 76 of the 96 responses who elaborated on how well their GTA PD program prepares GTAs either did not provide the data used to evaluate the program or did not answer the question correctly. Speer and colleagues believe two reasons for this lack of information. The first reason is the survey instrument, and the second reason is the evaluation of programs at these universities may not be as important. Similarly, Rasmussen and colleagues (2016) found approximately 55% of universities want more knowledge on how to evaluate PD programs.

Various groups of people can be used to evaluate PD programs. GTAs are a primary source for evaluation. For example, suggest obtaining data from GTAs before even entering a PD program. This data can be used for various comparisons of a program. GTAs' experiences can also be used to evaluate a program.

Students of GTAs have been another group of people that can be used to evaluate a PD program. Surveys have also been used to find differences in how students view GTAs that have taken PD as compared to GTAs that have not taken PD (Harris et al., 2009) or even how students

describe the best and worst GTA they have experienced (Bjorkman, 2016). Common characteristics that were more frequent in GTAs that took PD (e.g., more available outside of class time, welcome and encourage questions) relate to descriptions students used to describe the best GTAs (e.g., showing interest in students, affect, and preparedness). These studies not only show what students value in an instructor, but Harris and colleagues' results suggest PD can promote the desired characteristics in GTAs.

While student surveys are a common method of evaluating PD, Speer and colleagues (2017) caution that using only student evaluations to assess a program may provide inaccurate information. For example, students' enthusiasm about a course can affect how they complete course evaluations. Multiple methods of evaluation should be used to accurately evaluate a program (Speer et al., 2017; Patitsas, & Belleville, 2012).

Besides surveys, the literature discusses other methods to evaluate PD. For example, obtaining data on GTAs before and after PD, tracking changes in knowledge (Deshler et al., 2015), and comparing student test scores from classes taught by GTAs who participated in PD with scores from classes in which the GTA had no PD (Fausett & Knoll, 1991). Methods that do not involve students in the evaluation of PD are GTA portfolios (Deshler et al., 2015), GTA reflections on their teaching (Wakefield et al., 2017) and interviews of GTAs (Deshler et al., 2015; Harris et al., 2009; Cervello Rogers & Yee, 2017). Through interviews, one can evaluate how PD has helped GTAs with their confidence and comfort level with teaching (Harris et al., 2009), what aspects of PD GTAs value (Cervello Rogers & Yee, 2017), and other supports they need (Austin, 2002).

In summary, there are multiple methods of evaluating a PD program. Common methods are course evaluations, surveys, student success, GTA reflections, and GTA interviews.

Summary

Through the review of the literature, I familiarized myself with the history of PD in college and found that while it is not a new concept, there have not been many changes over the years. I also gained a better understanding of the general types of programs that are currently offered at universities.

I then turned to literature on the influences on teachers, and specifically how these influences relate to GTAs. I discovered that one difficulty for GTAs is trying to balance their roles as graduate students and their roles as instructors. Other influences on their teaching are their own experiences as students, which often consist of teaching approaches predominantly based on lecturing. One influence from literature, reflection, is not a common practice for GTAs since many of them have not yet taught. In many of the influences on GTA as teachers, PD may be able to support them in their growth.

I next reviewed a current trend in education: active learning. Research has shown that active learning has had positive effects on student learning, retention of material, and even on closing the gender gaps in mathematics. Active learning keeps the students engaged in the class and provides them an opportunity to discover concepts on their own. With having such positive effects on student learning, active learning should be introduced to all instructors. PD can provide GTAs this introduction as well as how to incorporate it in their classrooms.

I also reviewed components in PD programs previously researched. From the literature, I found that PD programs should provide pedagogical content knowledge, knowledge on student interactions and different teaching methods, and opportunities to be observed teaching or to observe other teachers. Many GTAs have not yet taught and therefore they are not familiar with teaching skills. However, the skills can be provided through PD.

Literature on evaluation of PD provided me with the current methods used to determine how a PD program is reviewed. Some common ways are surveys, student work, and interviews. While my work is not evaluating PD programs, the literature helped me determine that I needed more than one tool to better examine what GTAs value. Research has been done on PDs offered for GTAs and on how to improve programs, but little is known about GTAs' perception of the value of their experiences and of the value of undergoing the PDs offered at their universities. By understanding what GTAs find important, PD can be reviewed to better fit graduate students' needs. My study addresses GTA's perceptions by identifying what GTAs at one university value from their experiences in the PD program through a survey and interviews.

Chapter 3: Methods

Context of Professional Development Program

This study was completed at a research-intensive university in the Southwestern United States. In this section, I describe the Professional Development (PD) program in place prior to fall 2018 since this is the one that most of the participants in my study had experienced. Starting in fall 2018, a few changes were implemented, and I will briefly describe them at the end of this section. Prior to fall 2018, new GTAs generally started teaching their own section of college algebra. The PD offered for the GTAs had the following format. In August, prior to the beginning of the semester, the first year GTAs attend a three-day orientation. This orientation generally contains information in regard to the class most of the GTAs will be teaching, information about teaching in general, some of the logistics and teaching obligations in the department and at the university at large, as well as other information.

During the fall of their first year teaching, GTAs were required to take a course that met once a week. These weekly meetings were generally discussion-based and were led by three people in the department. Some of this course activities included writing some reflection assignments as well as completing peer observations of another first year GTA.

GTAs have a teaching supervisor throughout their whole teaching experience in the department. The supervisor usually changes each semester (in part based on the course the GTA is teaching and on the availability of supervisors). Teaching supervisors' duties included observing each GTA teach twice a semester, helping answer any questions, reviewing course syllabi and any tests the GTA wrote, if applicable, as well as overseeing and helping GTAs release final grades.

During the fall of 2018, the GTA program changed. Instead of teaching their own class their first semester, GTAs are usually now placed in larger sections (around 60 students instead of 35) with an experienced instructor. So they are no longer teaching their own course as their first GTA experience, but rather they co-teach for their first year (college algebra type courses) or assist with a developmental mathematics course. The three-day orientation in August is still in place for all new GTAs. The one semester course has been moved to their second year when most GTAs will teach their own course for the first time.

Participants

Participation in this study took two forms. The first portion of participation involved completing a survey. To recruit participants for the survey, I sent an email to all the graduate students in the mathematics program, the applied mathematics program, and the statistics program inviting them to participate in this study. The total number of students that received this invitation was 182. I received a total of 35 survey responses, though 14 of them were partially completed. Thirty-five people may look small; however, the invitation to participate in the study was sent to all graduate students in mathematics. Some of these students may have never taught, or taught a long time ago. This may have contributed to the low response rate. Unfortunately, there does not seem to be a listserv for only GTAs in the department.

The participants are graduate students ranging from their first year of study to their sixth. Of the three programs, 22 were in the mathematics program, 11 in the applied mathematics program, and 2 in the statistics program. For the highest degree obtained by the participants, 16 marked bachelor's degree, 17 marked master's degree, and 2 marked Ph.D. For the Ph.D. responses, the field was not specified. When asked what their career goals were, 13 indicated research, 14 industry, 14 academia, and 4 were not sure yet. Note the responses add up to more

than 35. This is due to people being allowed to mark more than one option. All but four respondents had previous teaching experiences. Typical experience included tutoring, teaching middle school, teaching as a GTA at a master's institution, and teaching at church. There were 22 male respondents, 12 female respondents, 1 other, and 1 preferred not to answer. Only 4 people identified as international.

The second form of participation in this study involved interviews. At the end of the survey, participants could choose to be interviewed. Of the people who took the survey, 14 people provided contact information for being interviewed. I emailed all of them to set up a time to interview; twelve people responded and were interviewed. Due to the population of GTAs being small, I do not provide details about each person interviewed in order to prevent them from being identified. Instead, I will provide some general demographic information about the interviewee population.

Five of the interviewees were in the applied mathematics program while seven were in the mathematics program. For future careers, six mentioned pursuing a career in academia, three said industry, four said national labs, and one said starting a school. Note the responses is more than 12. This is due to people providing more than one answer. The people interviewed ranged from 2 to 4 years as a GTA. Typical classes that they taught were college algebra, precalculus, calculus, calculus II, trigonometry, business calculus, and running recitation sections for differential equations. When asked if they had any teaching experience prior to coming to this university, all but two had some experience. Typical experience was tutoring during their undergraduate degree and teaching during their master's degree.

Data collection

My data collection was in two stages. First, I conducted a survey (as mentioned above, out of 182 potential respondents, 35 fully or partially completed the survey). Then I interviewed 12 of the survey respondents. Below I provide more information on the two instruments (survey and interview protocol).

Survey. Prior to creating my survey, I met with someone at the university familiar with creating surveys. She provided me with general information on how to create a good survey. Some examples of this information were: knowing what information I want to get from the survey before creating the survey; not having multiple parts to one question; having someone look through the survey prior to giving it in order to clarify questions. She also provided me information on how to complete an IRB (Human Subjects Research Application) as well as what program to use to create my survey.

After some research, I was able to narrow down what information I was looking for and how I was going to structure my survey. In the end, I chose to create my survey using the program Qualtrics. In the survey, my questions covered the following areas: demographics, GTA experiences with the PD program offered by the department, and the teaching styles/methods they had experienced as a student and used as an instructor. (See Appendix A for survey questions.)

Once the survey was completed, I had four people read through my survey questions to provide me with information that needed to be clarified or re-worded. After my study was approved by the University's IRB, I distributed the survey to the graduate students in the mathematics program, the applied mathematics program, and the statistics program.

Interviews. The final question of the survey asks, “If you would be willing to be interviewed (it will be audiotaped) over some items in the survey, please provide your name and email and/or phone number.” These interviews were semi-structured and lasted anywhere from 20 minutes to 70 minutes. During the interviews, the participants provided more details on some aspects of the PD, what they felt helped with their development as an instructor, and what aspects of teaching they would have liked to have learned more about. (See Appendix B for the interview protocol.)

Data Analysis

I sent the recruitment email out to the three graduate programs the first week of November 2018, and a follow-up email two weeks later. To obtain more responses, I sent the recruitment email out one more time in January 2019. Once I had obtained all of the survey responses, I emailed the 14 people that provided their information for the interviews at the beginning of February. I conducted the interviews from February to the end of April.

Analysis of survey data. After the second recruitment email was sent out, I started getting a sense of the content in the survey responses by looking at the responses and noting common topics that appeared throughout the data. I did a first “quick” read of all the responses looking for frequent topics (e.g. experiences with supervisors, answers that mention time as an issue). Once I had all of the data from the surveys, I printed out all of the responses and went through the data question by question. I cut the responses into individual strips and first put them into piles of similarities. After completing this once, I combined piles that had some similarities to create my themes. I realized it was becoming too challenging because some responses fit under more than one theme, so I put the responses one question at a time into a google document. I followed the same process described above, but instead of physically putting the data into piles, I would color code the data by similarities with a code word or phrase. I created my themes by

looking at my code words and completed this same process for the rest of the open-ended survey questions.

Analysis of interviews. I conducted most of these interviews in my office and recorded the interviews using my phone and computer to make sure all audio was captured. I started transcribing prior to finishing all the interviews. I completely transcribed the first two interviews. After that, I transcribed the interviews one question at a time. Once a question was transcribed for all twelve interviews, I put the transcriptions in one document. I would write a summary of each of the interviews for that particular question and then put the summaries in a document. From these summaries, I used the same coding process described for the surveys. Once I had all the questions transcribed and coded, I revisited all the audio files to check the transcriptions I was going to include in my thesis for accuracy.

Chapter 4: Findings and Discussion

The goal of this research study was to gain an understanding of GTAs' perceptions of the effectiveness of the different professional development (PD) components they participated in throughout their years as GTAs. My main focus was to answer the following question: What do GTAs value in the PD experiences offered? After analyzing all of the data collected from the surveys and interviews, I found the following five themes: interactions with peers, interactions with teaching supervisors, collaborative learning spaces, observations of instructors as an undergraduate and graduate student, and longer PD course.

Interactions with peers

GTAs felt interactions with fellow GTAs helped create a sense of community amongst the group as well as became another resource for them to utilize throughout their studying and teaching.

Throughout the survey and interviews, GTAs discussed how interactions with each other helped them realize common feelings, experiences, and issues with teaching. For example, one GTA discussed in the survey how the PD program helped calm their nerves about teaching through discussions with their peers at the pre-semester orientation. This person wrote, "[a]t the time I was very nervous about teaching for the first time, so it was nice to see that others felt the same way." This statement not only mentions the daunting task of teaching for the first time, but that they are not alone. The PD provided opportunities for them to meet and interact with others who were in the same position.

Fellow GTAs can also be a resource. As one person commented in the survey,

> "I found discussions with my peers or people teaching the same course as me at the time to be the most beneficial. We would discuss common mistakes and strengths in our students. The latter really helped me be more efficient with lesson planning."

The comment suggests interactions with GTAs provide support through sharing pedagogical content knowledge. Another example comes from Sophia's interview (all interviewee names have been changed). When discussing what helped most with her development as an instructor, Sophia appreciated talking with other GTAs about their shared experiences. She stated "I think the most helpful thing about that course [first semester PD meetings] was being able to talk to/commiserate with the other TAs in there about challenges we were having since we were all teaching the same class." Sophia found it helpful to talk about the challenges she was having in her class as well as see what others were facing. Being in the same year in the program and generally teaching the same course, these conversations can become a resource for GTAs. Others experiences in the same course provide ideas or information that can be applied to the classes that are currently being taught. It also provides resources that are course specific.

GTAs can relate to one another's experiences with teaching which in turn can become a resource for them to use throughout their instruction. For example, one person described one of their biggest struggles with teaching was "[t]ime management. I want to give all the time that I have to my students but that does not leave enough time for me to do a good job at the rest of my work." This person described the struggle they had of balancing their work as a student and as a teacher. While this comment does not suggest talking to other GTAs about this challenge, GTAs are some of the few people in graduate school that can relate to both the student role and the instructor role.

These examples show GTAs value student interactions, for they provide a sense of comradery as well as another resource which is not a new concept. Austin (2002) found GTAs recommended having the time to talk amongst their peers. The importance of such interactions may be due to them being specific to GTAs, for they share the student and teacher role. While GTAs can talk to their supervisors and other faculty as a resource, many of these individuals are at a different stage in their teaching career. The supervisors and faculty experiences are important, yet they may not be as relatable to a GTA at the time. Interactions with graduate students allow GTAs to find people who can relate to their situation. Literature suggests peer observations allow GTAs to see common struggles among peers, new ideas to implement, and constructive criticism (Reinholz, 2017; Cervello Rogers & Yee, 2017; Milbourne, 2018; Ellis, 2015). My research suggests common struggles and new ideas to implement can be determined through discussions and without completing peer observations (e.g. Sophia talking about commiserating with GTAs in the challenges faced while teaching). These interactions with fellow GTAs might not only help with their teaching, but they can also help their success in their own studies. They are able to obtain teaching advice relevant to the course they are teaching from someone with the same amount of teaching experience who also is balancing the time commitments of being a student (Beisiegel & Simmt, 2012).

Interactions with Teaching Supervisors

Another group of people with whom GTAs interact are their teaching supervisors. GTAs will have a teaching supervisor for as long as they are teaching at this university. As mentioned previously, the teaching supervisor is likely to change each semester. Throughout the survey and interviews, teaching supervisors were mentioned frequently. GTAs had mixed views of teaching

supervisors. Below I provide evidence of the different views GTAs had pertaining to their experiences with teaching supervisors.

Some GTAs discussed how interactions and feedback with teaching supervisors where beneficial. GTAs could "[discuss] with the supervisor over how the classes should go", and "ask [my teaching supervisor] when I'm unsure is also important, but I need that less and less as I teach more." From these two comments, GTAs find teaching supervisors as a resource to clarify course directions and any questions they may have, yet the second respondent did not think they needed this resource as much when they become more experienced. Another example is from Lucas. Multiple times in his interview, he described a teaching supervisor's feedback as helpful. Below are two examples. First he talked about how one of his supervisors helped him address some problems in his class.

> Lucas: [My teaching supervisor] came to observe me and they were [using the pronoun "they" to hide the identity of the supervisors] very honest with me. You know there were problems and [they] would say what my problems were. Then [they] would have very practical advice and stuff, and we would talk for long times like after [they] observed me. We would have a meeting and we would talk for a while. I really listened to [their] stuff very carefully and then made sure I address them next time [they] came and observed me.

This excerpt shows how a teaching supervisor's feedback was helpful. Lucas felt his teaching supervisor not only provided honest feedback on how his class was going, but would give him some ideas to try. By saying he would not only listen but incorporate the feedback he received into his teaching, he suggests that he valued his supervisor's feedback. In the second example, Lucas provides a general explanation of why he finds teaching supervisor observations to be helpful.

> Lucas: I think teaching is this big balancing act and I think you sometimes need an outside perspective like a supervisor to be like objectively able to observe you and say "you are doing too much of this" or "you need more of this", like sometimes you kind of lean on one side or the other and you need someone to call you out on it.

Lucas felt teaching supervisors help GTAs find the right mix of teaching methods and activities to use in the classroom by giving an outsider's perspective. Without this perspective, GTAs may not realize how their students are experiencing their teaching.

Other GTAs provided their frustrations with teaching supervisors. One survey response described an incident with a teaching supervisor and questioned what to do when they have issues with their teaching supervisor.

> Perhaps a more attainable goal would involve assessing on a regular basis what support is currently provided to TAs via supervisors. For example, I had a teaching supervisor who explicitly only observed my class to see how I managed teaching while injured [details of injury have been omitted to keep identity confidential], and proceeded to laugh loudly during my class each time I noticeably winced in pain at the board. Halfway through the class, they abruptly stood and walked out, letting the door slam behind them. They did not review a single exam I wrote, and did not observe my class a second time. I would not consider the experience valuable to my TA professional development. I would ask of my department: How do you expect TAs to address this type of situation? When do you communicate this method of address to new TAs? How will you protect a TA who provides such an identifiable complaint but simultaneously address the inappropriate behavior of the supervisor?

The comment suggests the GTA was very upset with the support received. This GTA claimed the teaching supervisor only observed the class to watch them teach while injured. Whether or not this is true, this is how the person interpreted the observation and suggests no working relationship existed between the GTA and teaching supervisor. The comment addresses a big concern: teaching supervisors not completing their duties. The statement also suggests the GTA wanted more support than their supervisor was providing. Not only did the GTA provide information of what the teaching supervisor did not do, he or she suggests regularly checking up on the support the GTAs get from the teaching supervisors. Furthermore, the GTA pointed to the importance of a system for them to be able to report these issues without repercussions.

The second example of the support provided from teaching supervisors was from Larissa, one of the interviewed GTAs. She described multiple times, throughout the interview, her thoughts on the teaching supervisor aspect of PD. One time she described her feelings about being observed by teaching supervisors.

> Larissa: I felt like the observations were just like a complete waste of time because I always felt like the people that observed me didn't actually care that much… most of the time it was just like..., so I would get really stressed about it and it would cause stress in my week. And then I would teach and then sometimes they wouldn't even meet with me so it was completely pointless. And then sometimes they would meet with me and they were like you did good. And I'm like okay what did I get from that? Nothing.

Later on in her interview Larissa described specific teaching supervisor experiences.

> Larissa: So for example, if you get [supervisor's name], they are really passionate and will tell you a lot but they never respond to emails. Ever. So I can't ever actually contact them if I have questions. So I feel like they are too busy to be a supervisor. And then on

> the other side of the spectrum, I would get like I had someone who, like they would respond to my emails but they clearly didn't give two shits, I was like "hey you observed me like a month ago do we need to meet? Like I would really like to hear your feedback" and they were like "we don't need to meet, it was fine" and I was kind of like okay, and I get so nervous when people come in and it's just such a waste of time

From these two excerpts, Larissa described her frustrations with the observation aspect of the teaching supervisor obligations. It seems she wanted to gain some useful feedback from her supervisors but did not gain any. This bothered Larissa because she would get nervous having someone, such as a supervisor, watching her teach, so she felt like it was stress that was unnecessary. This suggests that even though observations can make her nervous, she values the feedback she receives.

Another aspect of the experience with supervisors' points to the importance of establishing a relationship, as Jill explains below:

> Jill: Yeah um depends on the teaching supervisor but, well something that's frustrating to me is that they just randomly assign you a different one every semester so you can't really develop a relationship with any one supervisor
>
> Alyssa: Mhmm.
>
> Jill: So I wish they would just assign a supervisor and stick with it...

From this example, it seems Jill valued a working relationship with her teaching supervisor. She thinks there is a lack a connection or a relationship between teaching supervisors and graduate students because teaching supervisors change every semester, limiting the amount of time they work together. This lack of connection may prevent a GTA from fully using their teaching supervisor as the resource they are.

The evidence provided shows GTAs have mixed emotions for teaching supervisors. While some found them helpful (e.g., Lucas), others did not (e.g., survey response and Larissa). Teaching supervisors are a common aspect of the GTAs' professional development. Ellis (2014) noted that about 70% of the universities in her study incorporated faculty observations along with other aspects of PD. Similar to some evidence from this study, teaching supervisors have been found throughout the literature to be very helpful in supporting GTAs' development by being a resource through mentoring (Belnap 2005; Deshler et al. 2015; Patistsas & Belleville, 2012; Shana'a, 1965). While peer observations provide feedback on relatable struggles in the classroom, teaching supervisors can provide feedback to GTAs from their own teaching experiences that are specific to the university and the student population. Teaching supervisors can provide feedback to GTAs based on their experiences that peers may not be able to provide.

However other examples from this research (e.g., Larissa and the survey response) point to potential issues with supervisors that may make the experience not valuable. The one survey response directly said that they "would not consider the experience valuable to my TA professional development" after feeling their supervisor only observed them because they were injured. As mentioned above, Larissa went into great detail about how frustrated she was with teaching supervisors, because she was not receiving feedback. Similarly, Austin's study (2002) found that GTAs wanted even more mentoring and feedback from faculty.

One reason for the mixed emotions in how GTAs feel about teaching supervisors can be related to the limited time GTAs have with one teaching supervisor. While Jill was specific in saying she wished there was more time to create a relationship with teaching supervisors, this can be generalized to looking at what relationships are currently existing. It appears some GTAs

have had good relationships with teaching supervisors that they valued. Other GTAs had either poor or no relationships, which caused them to not see the value in this aspect of PD.

Despite the mixed emotions from the survey and interviews, teaching supervisors can play an important role in the development of GTAs. At this university, it is the only part that remains consistent throughout all their years in the program. Prior research, and this study, support teaching supervisors as being a valuable resource for GTAs when there is a good relationship between the GTA and teaching supervisor; however, this research shows there are some concerns with the GTA and teaching supervisor relationship that should be addressed in further research and implementation in PD programs.

Collaborative Learning Spaces

The topic of active learning was mentioned in some of the interview responses and surveys. In particular, Two GTAs referred to one specific aspect related to active learning: collaborative learning spaces. Although this aspect was only brought up by two participants, I decided to include their comments given that these collaborative classrooms are gaining momentum at this university. For example, currently in the department, the majority of first year GTAs teach (with an experienced instructor) in a collaborative learning space. So, while many of the participants in my study had not experienced teaching in these spaces, it is important to hear from those who had, as this can inform future PD for GTAs. Collaborative learning spaces are classrooms that are laid out to support active learning. These classrooms usually have tables set up in groups with whiteboards and markers available for the students to use in their groups, as well as multiple projectors and screens around the room. During the interviews, Larissa and Sophia stated they wanted more information on how to effectively use collaborative learning

spaces and active learning in general. Below is Larissa's response to what aspects of her teaching she wished she had more knowledge or support.

> Larissa: Collaborative learning. They kind of gave me my collaborative space for the first time, and I have never really used it before so it was kind of a learning curve which is probably why my test scores weren't that great the first time. So maybe if you were going to assign TAs to collaborative learning spaces like support them a little bit more with that?
>
> Alyssa: Yeah. Like did you get any support for it?
>
> Larissa: No.
>
> Alyssa: What about just using that sort of teaching style [used in collaborative learning spaces]? Did you get [support from the university]?
>
> Larissa: Not here... I feel like teachers that would come here, they probably don't even learn about collaborative learning. Because it is not covered in the TA seminar.

In this example, Larissa described how she felt she was given no support on how to effectively use collaborative learning, and she attributed the lower scores in her exams to this situation. Sophia also wanted more knowledge on collaborative learning spaces. She described how it is nice to have these options available, but the support is not there yet.

> Sophia: ...the school is getting a lot better about attractive spaces and things but that is very recent. We weren't really made aware of the different options that we had. And I think that that would be..., to have understanding about different types of spaces we can request as well as the different types of styles of classroom we could have. Additionally if we wanted to have more of like an inquiry based learning or other type..., if we want to teach that way there isn't really any guidance on how to adapt the curriculum that we are

given and the requirements. So it would be nice if TAs want to teach that way if we could request a specific supervisor that also teaches that way so that, or some way to be able to get more guidance.

Alyssa: Right.

Sophia: And how to, because unfortunately you know I think they feel like "okay we will let the full time people worry about those types of experiments" but we are the ones teaching the entry level math. So if we don't do it, nobody is going to give those students that chance to have you know, to be taught more effectively or whatever. So yeah those kinds of things and just in general access to better ways to just improve the environment for the students. It doesn't feel like TAs have the ability to make those kinds of changes but they still have the complete responsibility of the students anyway.

Through this passage, Sophia highlighted the use of collaborative learning spaces at the university. She addressed the recent exposure of these types of learning spaces and how, like Larissa, she feels more support is needed in order to effectively use those spaces. She also provided the suggestion of having specific teaching supervisors for graduate students wanting to use a different teaching method.

Sophia not only described collaborative learning spaces, she described active learning and teaching at the university in general. She feels like active learning is left for the full time instructors; however, that creates the problem of many entry level mathematics students not receiving this learning opportunity, since many of the lower level courses are taught by GTAs.

Larissa and Sophia seem to value the collaborative learning spaces offered at this university. Both feel like more support and understanding of these spaces should be provided. As

Sophia described, these spaces offer good environments for students to use, yet Larissa feels there is a learning curve to using these types of classrooms effectively.

There has not been a whole lot of research conducted on collaborative learning spaces yet and the teaching of entry level mathematics courses. While many types of active learning strategies (e.g. inquiry based learning (IBL) (Laursen, Hassi, Kogan, & Weston, 2014; Piercey & Militzer, 2017), inquiry oriented instruction (IOI) (Kuster, Johnson, Keene, & Andrews-Larson, 2017), and project based learning (PBL) (Evans, Friedman, McGrath, Myers, & Ruiz, 2017) and active learning in general have been studied, research on the learning space is scarce. With collaborative learning spaces becoming a new type of classroom used for active learning, GTAs are interested in learning how to effectively use them, for many of them will be the future instructors using these spaces.

Sophia's comment relates to another concern GTAs face. She felt GTAs did not have the authority to make certain changes in teaching. Beisiegel and Simmt (2012) and Muzaka (2009) also suggested GTAs can feel like they have no authority in classes they teach due to the rigid structure of the class curriculum. Taking it even further, Beisiegel and Simmt argue that this belief can affect their teacher role from thinking that they can be different in how they teach in comparison with their own professors to thinking that what they do will not matter. By providing more support in using the different types of learning spaces as well as teaching methods, GTAs may feel a stronger sense of ownership in teaching. They will be able to make decisions on how they teach rather than feeling a lack of options and autonomy in their teaching.

Observations as a Student

GTAs discussed observations as being helpful to their development. In the data from the survey responses and interviews, GTAs mostly referred to two main different kinds of teaching

observations: observations by their teaching supervisors and peer observations. I have addressed these in the sections on interactions with peers and on the teaching supervisor. Two GTAs commented on a third type of observation they valued: their observations of their own instructors. Through their interviews, they discussed how they learned different teaching methods through their experiences as a student. For example, Ryan explained how observations as a student have impacted his teaching:

> Ryan: Really observing, whether it was positive or negative, is a pretty good indicator of things you either should or shouldn't do. [M]ore broadly that's kind of what guided me. I mean when I was in undergrad I had some really phenomenal teachers and I just tried to emulate that basically.

Ryan then continued to describe the teaching style of one of his advisors from undergraduate school. This comment suggests Ryan not only valued his experiences as a student, but he also found a role model for teaching through his past instructors. Kevin had similar experiences as Ryan, but did not discuss a particular instructor from his past. Instead, he provided some examples of the teaching techniques he observed. He explained:

> Kevin: For the most part it has been just trying to incorporate what I have seen in my own classes [as a student], as to what I think is good and what is not
>
> ...
>
> Alyssa: What are some examples of what you have seen as a student?
>
> Kevin: Well there are things that I have liked and that I haven't liked. For example I enjoy when professors make people do presentations. I think from a teaching perspective, I see that as very beneficial, and so when I am a student, I've always tried to sort of gauge the activity not necessarily from the sort of perspective of myself as a student but what

does the professor gain from having me do whatever I am doing, so things like presentation or groupwork, I may not like the other people in the class and I may not like doing groupwork but the professor gains the ability to walk around the classroom, talk with students and interact often and so I try to incorporate things that I think good professors do more often.

Alyssa: What are some things that you have seen that you haven't liked?

Kevin: What are some things that I haven't liked...? If the professor uses straight lecture for 50 minutes that's no good. And I don't like overly open ended questions. Open ended questions in general can be useful, but they can't be so open ended that the students don't have any idea of what you are looking for. So if the students are wondering how it pertains to anything in the class that you are doing then it is probably too open ended. And they don't have any idea where to start.

These comments provide examples of the different teaching strategies that Kevin seems to have gained through observing his instructors. Kevin offers a nuanced perspective on the value of learning from observing his professors, as he looks at it from both the student's and teacher's point of view. He seems to have developed a better understanding on why instructors choose certain approaches when delivering instruction.

Upon hearing Ryan and Kevin's comments, it seems they valued their observations of their own instructors to help guide them while choosing the teaching strategies they may use. Observations of other GTAs teaching has been shown to be a valuable resource for GTAs (Reinholz, 2017; Beisiegel & Simmt, 2012; Harris et al., 2009; Shana'a, 1965). Observations made by GTAs as a student can be valuable in different ways than peer observations. First, GTAs are able to observe someone that may have more experience teaching. They can also

observe how to teach higher level mathematics courses than the ones fellow GTAs usually teach, which may be useful to GTAs that want to pursue careers in academia after graduate school. Besides the experience and the courses they are taking, their observations as a student can provide graduate students with an idea of how to teach, or even a role model for teaching, prior to becoming a GTA, as shown in Ryan's interview. The final reason observations made by GTAs as a student can be valuable unlike peer observations is that GTAs are able to experience the teaching method as a student. Both Ryan and Kevin commented on how they not only picked up on some useful teaching strategies, but they recognized teaching methods that they did not like as a student.

Longer Professional Development Course

Throughout the survey and interviews, GTAs talked about the support they wish they had received while teaching. One comment claimed "I feel more support is needed in the second semester. During the second semester there is very little oversight and as a result, very little feedback." From this response, the participant did not feel supported enough after the first semester. (Recall that for the participants in this survey, the more formal aspect of the PD program ended after their first semester of teaching.)

Similarly, other comments were made about the lack of support received when it came to writing tests. Generally at this university, GTAs start teaching college algebra. For this course, all of the exams are created by the course coordinators. After their first semester, GTAs may move on to teaching other courses, which require them to write tests. Below are some responses from the survey on the topic of test writing. The first respondent describes what they thought would have been helpful.

> I think more instruction on how to write an exam would have been helpful. They didn't teach it because we don't have to for college algebra, which is the first class we teach, but later we have to write them, and by then we have a lot less support.

Another person provided a similar response:

> I would say more practice creating lesson plans straight from a textbook and making tests. It feels like there was a big jump from what we had to do in college algebra to what we had to do in another class with a steep decrease in the amount of guidance received.

Both of these comments address the issue of writing tests that arise for most GTAs after their first semester of teaching. As one person previously mentioned, there is little oversight after the first semester. Besides the survey comments, test writing also appeared in the interviews. Sophia mentioned in her interview that PD should include skills needed to create tests.

> Alyssa: Okay so now kind of go the opposite way, thinking about your teaching here, what are some aspects or areas pertaining to teaching that you wish you had had more knowledge or support?
>
> Sophia: I would have liked, like when we were doing that theoretical study, we didn't talk about how to write exams because in college algebra you don't write any exams. But going forward we would need that skill for all the other classes we would teach, and we didn't so we were just kind of dropped into that. And I feel like there is a lot of pedagogical theory behind proper exam writing that I don't know and so I always felt like I was doing my students a little bit of a disservice. I would try my best to write a good exam but I am sure that with some more educational theory or whatever I could know some better principles on how to write better exams.

Sophia felt like she did not have the help she needed to write a proper test. She addresses that during the first course that GTAs usually teach at this university (college algebra), they do not need to write tests. Yet that is a skill they need for the future classes they may teach. She also highlights how not discussing this aspect of teaching could have potential effects on the student's learning. Besides writing tests, her comment brings attention to wanting information in the semester-long PD course that can be useful for their teaching beyond college algebra. Nathan highlights similar information in his interview. Below he describes wanting more general teaching strategies through the PD program.

> Nathan: So I do think that if the TA training was a little more focused on, not just TA training but even like discussions in the course, [but] would have focused on things like various, like even examples of teaching strategies for these sorts of things. Like general use for teaching strategies. Like group type stuff and things like that, I'm not talking about how to teach one particular thing, which there was a lot of. Like how to teach, whatever solving an equation or whatever it was.
>
> Alyssa: So they gave very specific.
>
> Nathan: Things to, that. Which fine, it was useful for that one course which I taught, but it was never useful again. While if it was more general useful teaching strategies which at least you could get some feel of, that would have been much more useful.

Nathan found that the information in the semester- long course was useful at the time, but it did not translate to future teaching. If the training would have been more general and not related to specific content, it may have been more useful. All of the previous comments address different aspects of teaching that they wished the GTAs' course had discussed. The following comment ties all of these ideas together. In one of the survey questions, GTAs were asked what

suggestions they would make to the PD program, and one response suggested having the GTAs' course last longer to better fit GTAs schedules:

> Spread it out over two semesters (with the current set up of GTAs not teaching their first year, this probably means during the 3rd and 4th semesters). Then the first semester can be used to give help with pushing along new teachers, while the second one can be focused more on good teaching habits and implementing different teaching styles. While it would be nice for most first semester teachers to be able to implement a variety of teaching strategies, most grad students are too busy their first semester lesson prepping on their own to really think this part through.

This person was interested in learning more, but wanted the content to be spread out over the course of a longer time period and suggested continuing the course for more than a semester so GTAs will receive the content in a way that is more accommodating to their busy schedules. This comment highlights what many of the other GTAs felt was lacking: support in the second semester. This GTA addresses that some GTAs need help getting through their first time teaching, and PD can help them through this experience. In some ways, it appears the course already does this (e.g., Nathan's comment of teaching specific content to students.) Yet this survey comment also suggests providing information that is broader and can be used throughout their teaching careers, which includes general teaching strategies (i.e., Nathan's comment) and writing exams (i.e., survey and Sophia's comment).

All the comments suggest GTAs value the support from the PD program, and in fact many suggested wanting more support. Beisiegel (2017) and DeFranco & McGivney-Burelle (2001), also discuss GTAs' views on PD support. These authors discuss different stages teachers go through. Beisiegel suggested four stages, with the first stage being survival through the first

year of teaching. The survey responses suggest GTAs obtained the support through the survival stage, but then it ended. DeFranco & McGivney-Burelle's (2001) argue that a longer PD program would support GTAs through the different stages of teaching. Similarly, in the last comment the GTA believed that the first semester could be dedicated to the "survival" stage of teaching and the following semesters could provide help with different stages or styles of teaching. Through a longer PD program, these GTAs may obtain more of the support they feel they are missing.

Summary

To summarize, through interviews and a survey, I found that the GTAs in this study value five different aspects related to the PD program offered. The first is interactions. Specifically they value the interactions with their peers, as they become a resource for both teaching and for balancing student/teacher roles. Although the experiences with teaching supervisors is inconsistent, the data suggests GTAs value these interactions too. The third topic was collaborative learning spaces. GTAs wanted more information on how to effectively use these spaces for teaching. Besides interactions and teaching spaces, GTAs talked about valuing their observations made about their own instructors. The final topic is that GTAs valued the support received through the semester-long course and wanted even more support throughout their time as a GTA.

In looking at the five themes, one can see some connections between development and control. Collaborative learning spaces and a longer PD program (with for example two courses instead of one) are related, for both are aspects of the professional development offered. Information on how to effectively use collaborative learning spaces can be included in one or both of the PD courses if the program was longer. When looking at the control GTAs have,

interactions with peers and observations as a student both allow the GTA control. In both cases, GTAs can decide what suggestions or components of their observations they would like to include in their teaching. In contrast, in looking the teaching supervisor theme, the GTAs do not have control in who their teaching supervisor is or the amount of time they are with one supervisor. They also do not have the same control as in their interactions with peers and their own observations as a student, for GTAs may not necessarily feel they have a choice of whether or not to include suggestions made by teaching supervisors.

Limitations

This section discusses some of the main limitations to the study. A couple of limitations arise from the design of the survey. Prior to distributing my survey, I had people review it to clear up any confusion; however, all reviewers had some teaching experience and were familiar with terms such as professional development. When the actual survey was administered, there were a few comments indicating that some of the terms were unclear (e.g., Professional Development). If I were to conduct this research again, I would make sure to have people without an education background review the survey so that I could clarify any terms that may not be familiar to the population that would complete the survey.

Another limitation in the design of the survey is that some of the questions did not ask the participants to specify which part of the PD program they were referring to in their answers. By having participants provide this information for each question, more accurate data would be obtained on the different parts of the PD program.

There was also a limitation with the survey distribution. During the analysis of my data, I found one person had completed the survey twice. I was able to determine that because their name showed up twice for being interviewed. To prevent this from happening, I should have

looked into different methods of sending out the survey so that if someone had already completed it, they would not be allowed to do it again.

One further limitation is with the number of participants who filled out the survey. Not only does the number seem somewhat low but also I wonder how representative it may be since those answering the survey maybe chose to do so because they knew me.

Another limitation to my study was my own positionality. I was a GTA, and so my experiences may have affected how I analyzed the data. To help mitigate any of my own bias, I had my advisor check some of my interpretations of the responses.

Chapter 5: Implications and Recommendations

Implications

The goal of this research study was to gain an understanding of GTAs' perceptions of the value of the different professional development (PD) components they participated in throughout their years as GTAs. Through a survey and 12 interviews I found that GTAs in this study value interactions with other GTAs and teaching supervisors, more information on the use of collaborative learning spaces, their own observations as students of their instructors, and a longer, more sustained PD program beyond the one semester long course. This study identified some topics that could use further understanding. The first topic is collaborative learning spaces. While research has addressed different types of teaching, research is limited on the types of spaces used for classes. From my study, GTAs would like more information on this and in order to have more information, research needs to be done on how these collaborative learning spaces affect teaching. The second topic is observations as a student. Studies show that observations made of GTA's teaching is beneficial but little is known about the impact of what GTAs learn about teaching from their experiences observing their own instructors. The third area where more research should be completed is on the impact of teaching supervisors on GTAs. While some GTAs in my study valued the resources that teaching supervisors could bring to their development as teachers, others had rather negative experiences. This study only addressed what GTAs valued from their PD experience at one university. A similar study at multiple universities could identify a wider array of experiences that GTAs value. The final suggestion is about the evaluation of PD, which this study did not address. As previously mentioned, Speer and colleagues (2017) found from a survey that 40% of the institutions that participated in the survey were not satisfied with their current PD and Rasmussen and colleagues (2016) found

approximately 55% of universities want more knowledge on how to evaluate PD programs. Similarly, this study highlights some areas of PD that could use some improvement (e.g., role of teaching supervisors). Prior research and this study findings show there is still a need for stronger evaluation of PD.

Recommendations

Based on the findings from this study, I would like to offer the following recommendations that developers of a PD program for GTAs could consider:

1. *Weekly GTA meetings:* the results of this study show GTAs value interactions with one another and wanted a longer PD program. Through weekly meetings, GTAs are able to interact with their peers. This will help create an even stronger community among GTAs that may affect their teaching (e.g., learning different methods of teaching, understanding common struggles among students) as well as their own studies (e.g., time management skills, creating study groups, cutting back on lesson planning through sharing plans). It will also provide PD opportunities that last longer than one semester.
2. *Teaching supervisor orientation:* GTAs had mixed experiences with the support received from their teaching supervisors. It seems that many of the negative emotions could have been prevented if the expectations of being a teaching supervisor were clear. Just as GTAs need support in becoming a teacher, teaching supervisors need help in knowing the expectations from the department of this role as well as expectations from the GTAs they are supervising. A specific content area to address in this orientation would be how to provide useful feedback from teaching observations.
3. *Teaching supervisor evaluations:* Currently, the department has students as well as teaching supervisors evaluate GTAs. Similarly, the department and GTAs should provide

evaluation of teaching supervisors. This can be done through an evaluation survey sent to the GTAs. So GTAs feel safe about providing feedback, the results of the survey can go to a third party that can eliminate any identifying information from the survey responses. Through this survey, GTAs will have an opportunity to let the department know how well they feel their teaching supervisor is completing their duties. In doing so, an accountability component will exist so teaching supervisors complete their duties. It would also provide more data for the department to use so they can continue to improve their PD program.

4. *Collaborative Learning Spaces PD*: Given the move towards an increased use of these spaces, seminars or weekly meetings that show GTAs effective ways to use these collaborative spaces should be provided. Furthermore, pairing teaching supervisors who have experience with teaching in these spaces with GTAs who are also teaching in these settings would provide even more support.
5. *Test writing seminars:* Many GTAs wanted help on how to write an exam. During their first semester teaching a course where writing an exam is involved, PD can include a seminar that provides information on writing exams.
6. *Longer PD program*: In the current design (which is not the participants in the study had experienced) PD has already been stretched to two years. During the first year, GTAs help another instructor in their classroom. This provides them the experience working with students and can serve as a teaching internship. In their second year is when many of them may teach their own course for the first time. They have a weekly PD course during their first semester of their second year. While this model may address some of the concerns that the GTAs in the study raised, still extending the one-semester course during

the second year to the whole year, or implementing a second semester long course later in their teaching career (e.g., when some of them may be teaching calculus for the first time) would provide further support.

7. *Observe experienced instructors:* GTAs described observations as a student useful for it served as a resource in showing different teaching methods. By having GTAs observe experienced instructors, GTAs can not only see different teaching methods, they can observe instructors teaching courses that GTAs currently teach or may be teaching in the future.

These recommendations reflect what GTAs valued in their experiences with the PD program offered at one university. Hopefully these recommendations can help with the development of PD programs by aligning the program with the needs of the graduate students.

Appendix A

Survey Questions

Q. Have you been a Teaching Assistant (TA) at the University of Arizona?

Q1. What is your gender identity?

Q2. Are you an international student?

Q3. What is the highest degree you have obtained?

Q4. What are your future career plans?

Q5. How many years have you been a teaching assistant (TA) at the University of Arizona?

Q6. What previous teaching or tutoring experiences do you have prior to attending the University of Arizona for graduate studies? Please explain.

Q7. What graduate program are you enrolled in at the University of Arizona?

Q8. Do you feel the TA professional development at the University of Arizona has prepared you for teaching? Why or why not?

Q9. What activities in the TA professional development did you find most beneficial? Why?

Q10. What activities in the TA professional development did you find least beneficial? Why?

Q11. What suggestions, if any, would you make to improve the overall TA professional development?

Q12. If you remember, what teaching methods were discussed in the TA professional development? When were they discussed (pre-semester orientation, semester meetings, individual meetings)?

Q13. What teaching methods have you implemented or plan to implement in your teaching that you have learned from the professional development?

The next couple of questions discuss active learning and lecture style teaching. For this survey, we define

active learning -*engaging students in the process of learning through activities and/or discussion in*

class, as opposed to passively listening to an expert. It emphasizes higher- order thinking and often involves group work.

Lecture style teaching - *a method where the instructor is the primary source of information through lecture and use of PowerPoint, white board, and/or other visual aids. Students are expected to take notes and little conversation occurs between teacher and students.*

Q14. As a student, what percent of your undergraduate mathematics courses used the following learning methods?

Lecture style, Active learning, Other (please explain)

Q15. What percentages of your graduate mathematics courses used the following learning methods?

Lecture style, Active learning, Other (please explain)

Q16. In general, when you teach at the University of Arizona, what percent of the time did you use these teaching methods?

Lecture style, Active learning, Other (please explain)

Q17. If you have used active learning, how did you first hear of this teaching method?

Q18. To date, what has been the biggest challenge you have faced teaching?

Q19. What has been your biggest accomplishment (or you are most proud of) teaching?

Q20. If you would be willing to be interviewed (it will be audiotaped) over some items in the survey, please provide your name and email and/or phone number.

Appendix B

Interview protocol

First I want to thank you for completing my survey and for agreeing to be interviewed. As I mentioned in my email, I am interested in understanding more about TA PD experiences, so this is a chance for you to tell me more about your experiences. I just want to remind you that I will be the only one listening to the interview. When writing my thesis, I will make sure to change names so your comments will remain completely anonymous. Before we get started do you have any questions for me?

1. To start off, can you tell me what program are you in?
2. How many years have you been at [university's name]?
3. What are your career goals?
4. What courses have you taught at the [university's name]?
5. Prior teaching experience? [Tutoring?]
6. Ok, let's turn to your experience as a TA. When you first heard you would be a teaching assistant, what did you expect your role to be?
7. This may be a very broad question but I'm wondering, as you think about your teaching at [university's name], what are some aspects that helped your development as an instructor? [grow as an instructor]
8. Also thinking about your teaching at the [university's name], are there some aspects or areas pertaining to your teaching that you wish you had more knowledge and/or support?
9. Now I want you to think about your teaching supervisors that you have had the past few years. How were your experiences with your teaching supervisors?

10. Have you made any changes to your teaching style? If so, what are examples…?
11. Is there anything else that you would like to share about your experiences with the TA PD at the [university's name] that we have not already talked about?

I want to thank you again for your time!

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